TRICK PLAY USING CRT SCAN MODES

The invention relates to the field of video display with trick play modes.

Recently CRT monitors with multiple scan modes have become more popular. Usually there are at least two scan modes. In the Americas, one scan mode has a 60 Hz scan rate for displaying 30 frames per second (60 interlaced fields), and the other mode has a 120 Hz scan rate for displaying 60 frames per second (120 interlaced fields). In most of the rest of the world the scan rates are 50 Hz and 100 Hz. The scan mode can usually be selected using buttons on the front of the monitor or by accessing a menu. Often, when operated in the mode with the 60Hz scan rate and interlaced frames, there is some barely detectable flicker especially in a room that is brightly lit with fluorescent lighting. On the other hand, when operated in the mode with an 120 Hz scan rate, there may be distortions in brightness, contrast, or color because of the difficulty in aiming the electron gun of the CRT at such high scan rates. For this reason, monitors having duel 60/120 modes are often operated at the 60 Hz mode rather then the faster mode.

For computing tasks 60 and 120 Hz frame display rates are convenient because computer hardware usually supports providing display frames at these rates. However for video display, the frames are not necessarily at these rates.

The MPEG video standard specifies several standard frame rates for normal real-time display and includes a frame rate code that indicates the frame rate for normal real-time display. For movies the frame rate is 24 per second, and for American television the frame rate is usually 30 per second (25 in most of the rest of the world). If a display device such as a CRT has a display rate that is higher than the MPEG frame rate, then the decoder can simply drop some frames. More commonly, if the MPEG frame rate is a lower rate

then the frame rate of the display, then frames can be repeated or additional frames can be derived by averaging between sequential frames.

Video sources such as VCR drives and DVD drives usually also provide for trick play speeds. Common trick play speeds include forward and reverse play at various multiples of the normal play speed such as 1/2 X, 2X, 4X, 8X and 16X. These trick play modes are often provided using the same frame display rate and just dropping some of the frames or repeating some of the frames. For example, for 4X play, only every fourth frame is displayed so that three frames are dropped between each two successive frames that are shown.

Those skilled in the art are directed to US application 09/281013 filed 3/30/99 (WO 00/59219 published 10/5/00) and WO 00/57241 published 9/28/00 which describe trick mode implementations on display devices. Also, those skilled in the art are directed to US application 10/185,905 filed 06/28/02 describing conversion of video formats to 120Hz 4X interlaced format. These citations are hereby incorporated herein in whole by reference.

In the invention herein, a display device is provided which has multiple fixed predetermined display scan modes with corresponding frame display rates that are independent of the average frame input rate and selectable at least between: a first mode and a second mode that is substantially different than the first display rate. Video frames of a video program are provided with a predetermined standard average input rate that is selectable at least between: a slower average input rate and a faster average input rate that is substantially different than the slower input rate. The display scan mode of the display is selected so as to select the first mode when receiving frames at the faster input rate and to select the second mode when receiving frames at the slower input rate.

The first display scan mode may have a higher frame rate, the advantage of this is that fast trick play modes have a less jerky appearance, when fewer frames are dropped. The first mode may be a progressive display scan mode and the second mode may be an interlaced display scan mode and the display device may have a converter for converting progressive frames at a fast rate to interlaced frames at a lower frame rate.

Additional aspects and advantages of the invention will become readily apparent to those skilled in the art from the detailed description below with reference to the following drawings.

Figure 1 illustrates the method of the invention for automatically providing correspondence between the scan mode of a display device and the input frame rate.

Figure 2 illustrates an example video system of the invention for automatically providing correspondence between a input frame rate and the display scan mode.

Figure 3 illustrates an alternative example video system of the invention for automatically providing correspondence between an input frame rate and the display scan mode.

Figure 4 illustrates yet another example video system of the invention for automatically providing correspondence between a input frame rate and the display rate mode of a display device for trick mode play.

In the following descriptions of the drawings, the same labels in different figures indicate similar devices. For convenience, such devices will only be described in detail in relation to the earliest described figure in which they appear.

Figure 1 is a flow chart showing a specific example of the method 100 of the invention for automatically providing correspondence between a input frame rate and the display rate mode of a display device for trick mode play. In step 102 a display device is

provided that has multiple fixed predetermined display scan modes with corresponding frame display rates that are independent of the average frame input rate and selectable at least between: a first scan mode and a second scan mode that is substantially different than the first scan mode.

Most pixilated displays have a pixel refresh rate that defines a frame display rate. Typically those frame display rates are predetermined fixed, hardware dependent rates. Those skilled in the art could modify any such devices to provide multiple different frame display rates that could be automatically selected. In addition, common existing multi-mode display device include multi-mode CRTs, LCDs, plasma displays and LCOS projectors. The display scan modes of those devices are commonly manually selected, but those skilled in the art could modify such devices for automatic selection of mode depending on an indication of the rate at which frames are being provided. For example, the display device could automatically detect the frame input rate or the display device could receive a command from the video source indicating a change in the input rate, or the display device could receive a user input command to change the input rate.

In step 104, video frames of a video program are provided. The program has predetermined standard average input rates that are selectable at least between: a slower average input rate and a faster average input rate that is substantially different than the slower input rate.

The video frames could be provided by a video source such as a DVD drive or a digital VCR drive, or a magnetic disc drive (hard drive). A user input device could be provided to select between predetermined average input rates at which the frames could be provide to the display. The user input could be, for example, a keyboard, a remote control, or buttons on the front panel of the video source.

In step 106, the mode of the display device is automatically controlled to select the first mode with a when receiving frames at a faster input rate and to select the second mode when receiving frames at a slower input rate.

The automatic control of the display device may be provided by a detector for determining the input frame rate and a processor for changing the display scan mode depending on the input frame rate. Alternatively, the display device may receive a command from the source of the video frames to change the display scan mode depending on the selected input frame rate. Another possibility is that a user input device may be provided, and the input of a command to select operation at a display scan mode may also control the selection of a input frame rate.

The invention herein can be used in many different ways. The slower frame input rate may constitute a normal play mode and the faster input rate may constitute a fast motion mode. Alternatively, the slower input rate may constitute a slow motion mode and the faster input rate constitute normal real-time play. Also, both input rates may be for different slow motion modes or both input rates may be for different fast motion modes.

For either the slower or faster frame rates, if the frame input rate is slower than the frame display rate then at least some received frames will have to be repeated. Also, for either the slower or faster frame rates, if the frame input rate is higher than the frame display rate then some frames will have to be dropped.

Usually input rates for slow motion trick modes are simply integer divisions of the normal real-time frame input rate (positive integers for forward modes and negative integers for reverse modes). This simplifies the implementation of slow motion, because each frame can be repeated the same number of times. Similarly the input rates for fast motion trick play modes are simply integer multiple of the normal real-time frame input

rate. This simplifies the implementation of fast motion trick play because then the same number of frames can be dropped between each frame that is displayed.

It is convenient if the faster input rate is twice as fast as the slower input rate, because for most current multi-mode display devices there are two modes in which one is twice as fast as the other.

To simplify implementation and minimize jerkiness if the slower display rate were equal to the slower input rate, because then, every frame would simply be displayed one time, and there would be no repeated or dropped frames. Similarly, it would simplify implementation and minimize jerkiness if the faster display rate were equal to the faster input rate, because then, every frame would simply be displayed one time, and there would be no repeated or dropped frames.

For example, the input frames in both the slower and faster input rate may be provided in a progressive scan format with he first display scan mode at a 25Hz or 30Hz progressive scan mode and the second display scan mode at 50Hz or 60Hz progressive scan mode.

Alternatively, the input frames in both the slower and faster input rate may be in a 2X interlaced scan format with the first display scan mode, a 50Hz or 60Hz 2X interlaced scan mode, and the second display scan mode, a 100 Hz or 120Hz 2X interlaced scan mode.

Figure 2 illustrates an example embodiment of a video system 120 of the invention in which the mode of a display device is automatically corresponds to the average input frame rate provided by the video program source. In this example of a specific embodiment, in video program source 122, the average frame rate of a medium drive 124 is selected using user input device 126.

The medium drive may be an optical medium drive such as a DVD drive or a video CD drive or it may be a digital VCR tape drive, or a magnetic hard disc drive containing a video program. The medium drive is capable of providing video frames at a normal real-time play rate for the program or at trick play rates that are slower or faster than the normal play rate.

The user input may be buttons on the front panel of the video medium drive or a remote control capable of communicating with the video medium drive, or the user input may be a computer keyboard that communicates with the video medium drive through a personal computer and/or home network.

The video program source 122 provide frames to a display device 130. The display device includes a multi-mode display 132 that receives the frames through buffer 134. A processor 136 detects the input frame rate of the buffer 134, and automatically selects the display scan mode of the multi-mode display depending on the input frame rate.

The multi-mode display may be a CRT which is capable, for example, of displaying frames at a rate of either 30 frames or 60 frames per second. Alternatively the muti-mode display may be an LCD screen, a plasma display screen, or a display projector.

The display device displays frames at a faster rate when frames are received at a fast average rate, and the display device displays frames at a slower rate when frames are received at a slower average rate. For example, an MPEG movie may have a normal play input rate of 24 frames per second and in response to this frame rate the display will display frames at the rate of 30 frames per second. In order to display more frames than are received, the display device will occasionally display some of the frames twice. Buffer 134 stores the frames so that they can be displayed multiple times for slow trick play modes. When the video program source goes into a fast motion trick mode such as 4 times normal

speed (called 4X) (60 frames per second), then the display device will detect the faster frame rate and switch the operating mode to 60 frames per second. The display device will have to occasionally drop some of the video frames, but will not ever have to drop two frames in a row. For programs with normal display rates of 24 or 30 frames per second, Display of 4X speed on a display operating at 60 frames per second appears smooth, whereas even 2X speed appears jerky on a display operating at 30 frames per second.

Alternatively, when the user inputs a command through user input 126, to initiate a fast motion trick play mode, then video medium drive 124 provides a command to the display device to automatically switch the display device to operate in a mode for displaying frames at a faster rate. Processor 136 receives the command and selects a faster rate mode for the multi-mode display 132. In this case there is no need for processor 136 to detect the input frame rate.

converter 128 converts the input frames as required for the display device. For a slow motion trick play mode the converter may repeat frames or for a fast motion trick play mode the converter may drop frames or combine frames so as to provide the frame rate required for the display device scan mode. The converter may convert frames formatted for progressive scan to frames formatted for interlaced scans, for example, to reduce the frame rate. The conversion of the converter is also controlled by the user input command.

For example, multiple frames with a progressive scan format may be combined by combining some of the lines of each frame together to form a combined frame with a progressive scan format. Thus n frames may be combined using every n th line of each of the n frames to form the combined frame, every n th line beginning at a different line for each different frame. For example, a pair of frames are combined by combining the odd lines of one frame with the even lines of the other frame.

In another example, multiple frames with a progressive scan format may be combined by dropping lines of each frame to form a combined frame with an interlaced format. Thus, n frames may be combined by dropping all the lines except every n th line of each frame, every n th line beginning at a different line position in each different frame of the n frames.

In yet another example, multiple frames with an interlaced format may be combined by dropping one or more fields of each frame to form a combined frame with an interlaced format. For example a different field from each frame can be combined to form the combined frame.

In yet another example, multiple frames with an interlaced scan format may be combined by dropping lines of each frame to form a combined frame of interlaced format. Thus, n frames can be combined by dropping all the lines except every n th line of each field, every n th line beginning at a different line position in each different frame of the n frames.

In figure 3, Display device 142 includes processor 142 communicating with user input 126. When a user inputs a command through user input 126 to select a fast motion trick play mode, then processor 142 automatically selects a display scan mode with a higher frame display rate and the processor sends a signal to video program source 124 to automatically provide frames at a faster frame rate. In this case converter 128 is provided as part of the display device.

In figure 4, user input device 150, communicates directly with both the video program source 122, converter 128, and the display device 130. When the user inputs a command to operate the system in a fast motion trick play mode, then the same command

automatically causes the video program source 122 to provide frames at a higher input rate and the display device 130 to switch to a higher display rate.

The invention has been described above in relation to specific example embodiments. Those skilled in the art will know how to modify these example embodiments within the scope of the invention herein. The invention is only limited by the following claims.